# COST AND PERFORMANCE REPORT

Pump and Treat of Contaminated Groundwater at the
Mystery Bridge at Hwy 20 Superfund Site
Dow/DSI Facility
Evansville, Wyoming

February 2005

EPA
Prepared by:
U.S. Environmental Protection Agency
Office of Superfund Remediation Technology Innovation (OSRTI)

## SITE INFORMATION

**Identifying Information:**

Mystery Bridge at Hwy 20 Superfund Site
Dow/DSI facility - volatile halogenated organic (VHO) Plume
Evansville, Wyoming

**CERCLIS #:** WYD981546005

**ROD Dates:** September 24, 1990

**Treatment Application:**

**Type of Action:** Remedial

**Period of operation:** March 1994 - March 2001 (Performance data collected through October 1997)

**Quantity of groundwater treated during application:** 192.8 million gallons through December 1997

**Background**

**Historical Activity that Generated Contamination at the Site:** Oil and gas production enhancement

**Corresponding SIC Code:** 2911 (Oil and gas production enhancement)

**Waste Management Practice That Contributed to Contamination:** Various contaminant releases, spills, and leaks.

**Operations: [1,2,6,9]**

- The Mystery Bridge Superfund site encompasses 400 acres, and is bordered on the north by the North Platte River, to the south by several industrial facilities, and to the east and west by the Brookhurst/Mystery Bridge subdivision. The remedial action at the site addresses several groundwater contaminant plumes, emanating from several separate properties (KN Energy and Dow/DSI. Another source of contamination, from the Little America Refining Company, was not addressed as a remedial action for this site under CERCLA). The plumes contain different sets of contaminants, and each is being treated in a separate treatment system. This report addresses the remedial actions undertaken to address the plume originating from the Dow/DSI facility only.

- In 1986 residents complained of poor water and air quality. In response, EPA conducted an Expanded Site Investigation, which led to the original discovery of contaminants in the groundwater.

- The 23-acre Dow/DSI facility is situated along the Burlington Northern Railroad (BNRR) line, east of Evansville, WY. Since 1958, the site was used as a base for oil field service operations. Dow/DSI used mobile pumps, tanks, and other equipment to perform services for the oil and gas industry. It is believed that wash water from equipment cleaning operations contained chlorinated solvents. In addition, a large tank was located at the northern end of the site and was used to store large volumes of toluene, used for cleaning purposes and oil-well servicing activities.

- Releases were suspected from both the equipment cleaning activities and the toluene storage tank. Wash water from equipment cleaning operations flowed into a 1,000-gallon underground oil-water separator, located on the western portion of the site. Wash water from the oil-water separator sump seeped into the subsurface soils and the underlying groundwater. In addition, various spills and leaks were suspected to have occurred around the toluene storage tank, contaminating the subsurface soils in that area, as well.

- Beginning in January 1988, removal activities began at the Dow/DSI site, when approximately 440 cubic yards of contaminated soil were removed from the sump area and landfilled by Western Water Consultants (WWC). At the same time, the oil-water separator, an underground waste oil tank, and portions of the tile drain were removed by WWC. Soil vapor extraction (SVE) systems were installed in the sump and toluene storage areas to remove contaminants from subsurface soils. No further source control activities were performed.

- The sump area SVE system consisted of two extraction wells and 80 feet of horizontal collector pipe. The extraction wells were installed to within two to four feet above the highest recorded water table level. The collector pipe was installed at a depth of five feet. From April to August 1988, approximately 334 pounds of volatile organic compounds (VOCs) were removed from the sump area.

- The toluene storage area SVE system consisted of two wells, installed to within two to four feet of the highest recorded water table level. From April to August 1988, approximately 6,000 pounds of VOCs were removed from the toluene storage area.

- In December 1987, an Administrative Order on Consent was issued to Dow/DSI (and KN Energy), requiring them to perform a remedial investigation/feasibility study (RI/FS). The RI/FS was completed in June 1990 and concluded that a plume of groundwater contaminated with volatile halogenated organic (VHO) compounds extended from the Dow/DSI facility to the North Platte River, approximately 0.5 mile downgradient. Another plume was identified originating from the KN Energy facility, but the RI/FS concluded that the two plumes had different sources, contained different compounds, and were not commingled.

- The site was placed on the National Priorities List (NPL) in August 1990.

- The pump and treat system operated continuously from June 1994 to March 2001. In March 2001, the system was discontinued due to the discovery of a layer of Light Non-Aqueous Phase Liquid (LNAPL) in one of the monitoring wells. The water surface in the re-injection tank in the pump and treat building had developed an apparent oily film. Results of analyses indicate that the LNAPL is most likely weathered lean oil and is most likely drainage of residual product from the pore spaces in the deep unsaturated zone during a period of low groundwater levels at the site. The pump and treat system has not been restarted. Quarterly groundwater monitoring continues at the site and has indicated that contaminant concentrations have decreased but remain above cleanup goals.

- In September 2004, a five-year review was conducted which stated that concentrations of tetrachloroethene (PCE) at the site were detected at levels above the MCLs but generally remained below 11 : g/L. Concentrations of PCE were detected at levels as low as the MCLs in nearby residential areas. However, the review states that, “The ROD further recognized that contaminant levels may cease to decline and may remain constant at levels higher than the remediation goal.” and that, “The remedy as implemented is currently protective of human health and the environment.” The review recommends that the site implements institutional controls on groundwater use and continues the groundwater monitoring program.

- A five-year review is scheduled to take place in August 2009.

**Regulatory Context:**

- On September 24, 1990, EPA issued a Record of Decision (ROD) for the groundwater operable unit. This operable unit covers the remedial activities at both the KN Energy and Dow/DSI facilities.
- A Consent Decree for the RI/FS was signed in 1988 between USEPA, Dow/DSI, and KN Energy.
- Site activities are conducted under provisions of: the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (CERCLA/SARA) §121, the National Contingency Plan (NCP), 40 CFR 300; the Safe Drinking Water Act of 1974, as amended by 1984 reauthorization and amendments; Clean Air Act and 1990 Amendments; and the Resource Conservation and Recovery Act (RCRA) of 1976 and 1984 amendments.

**Remedy Selection:**

Groundwater extraction and treatment in the on-site portion of the plume via air stripping was selected as the remedy for the Dow/DSI VHO plume at this site. Effluent was to be reinjected to the alluvial aquifer. Contamination in the off-site portion of the plume was to be eliminated through natural attenuation.

## Site Logistics/Contacts

**Site Lead:** EPA-Lead

**Oversight:** State of Wyoming

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**Remedial Contractor:**
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* Indicates Primary Contact

## MATRIX DESCRIPTION

### Matrix Identification [1,2]

**Type of Matrix Processed Through the Treatment System:** Processed Through the Groundwater

### Contaminant Characterization

Halogenated volatile organic compounds

**Primary Contaminant Groups:** Heavy metals and volatile organic compounds (VOCs)

- The primary contaminants of concern at the site are 1,1-dichloroethene (1,1-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), trichloroethene (TCE), tetrachloroethene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), and 1,1-dichloroethane (1,1-DCA). Concentrations of toluene in the groundwater near the toluene storage tank did not justify it being considered a contaminant of concern.

- The maximum concentrations detected for the principal contaminants during the September 1989 sampling event included: (trans-1,2-DCE) 500 : g/L, (TCE) 430 : g/L, (PCE) 540 : g/L, and (1,1,1-TCA) 500 : g/L [1].

- To assess the likelihood that contaminants were present as nonaqueous phase liquids NAPLs), samples were taken by WWC at discrete intervals in one well, which was screened across the aquifer. Relatively higher concentrations in samples taken at the top and bottom of the aquifer than those found in the central portion would have indicated the presence of NAPLs. No such evidence was found.

- Figure 1 shows that the VHO plume extends from the DSI facility through the subdivision in a northeast direction towards the North Platte River. The areal extent of the plume was estimated during the RI/FS to be approximately 135 acres and to contain 18,571,000 gallons of contaminated groundwater.

### Matrix Characteristics Affecting Treatment Costs or Performance [1]

**Hydrogeology:**

Groundwater moves across the site in a northeasterly direction towards the North Platte River. An alluvial aquifer is located in an erosional trough in the bedrock surface. The alluvial aquifer is composed of permeable, unconsolidated materials. The aquifer is bound on the northwestern and southeastern sides by subcrops of bedrock rising above the water table, limiting drainage from adjacent basins. Underlying the alluvium, the bedrock is composed of sandstone, interspersed with shale seams. Groundwater is found at an average depth of 35 feet below land surface, and flows at an average rate of 2.1 feet/day. A technical description of the alluvial aquifer is given below:

Alluvial Aquifer The alluvial geology consists of 14.5 to 81 feet of quaternary alluvial floodplain and terrace deposits along the North Platte River and Elkhorn Creek. The upper 1.5 to 13 feet of the alluvial deposit is a surficial soil layer, which consists of a mixture of sandy silt and clayey silt. The remaining alluvium ranges in thickness from 13 to 68 feet (average thickness of 50 feet) and consists of well-sorted coarse to medium sand with little fine sand and trace amounts of silt and gravel. The depth to the groundwater in the alluvium ranges from 14 to 42 feet. The aquifer is underlain by non-water-bearing bedrock.

## MATRIX DESCRIPTION (CONT.)

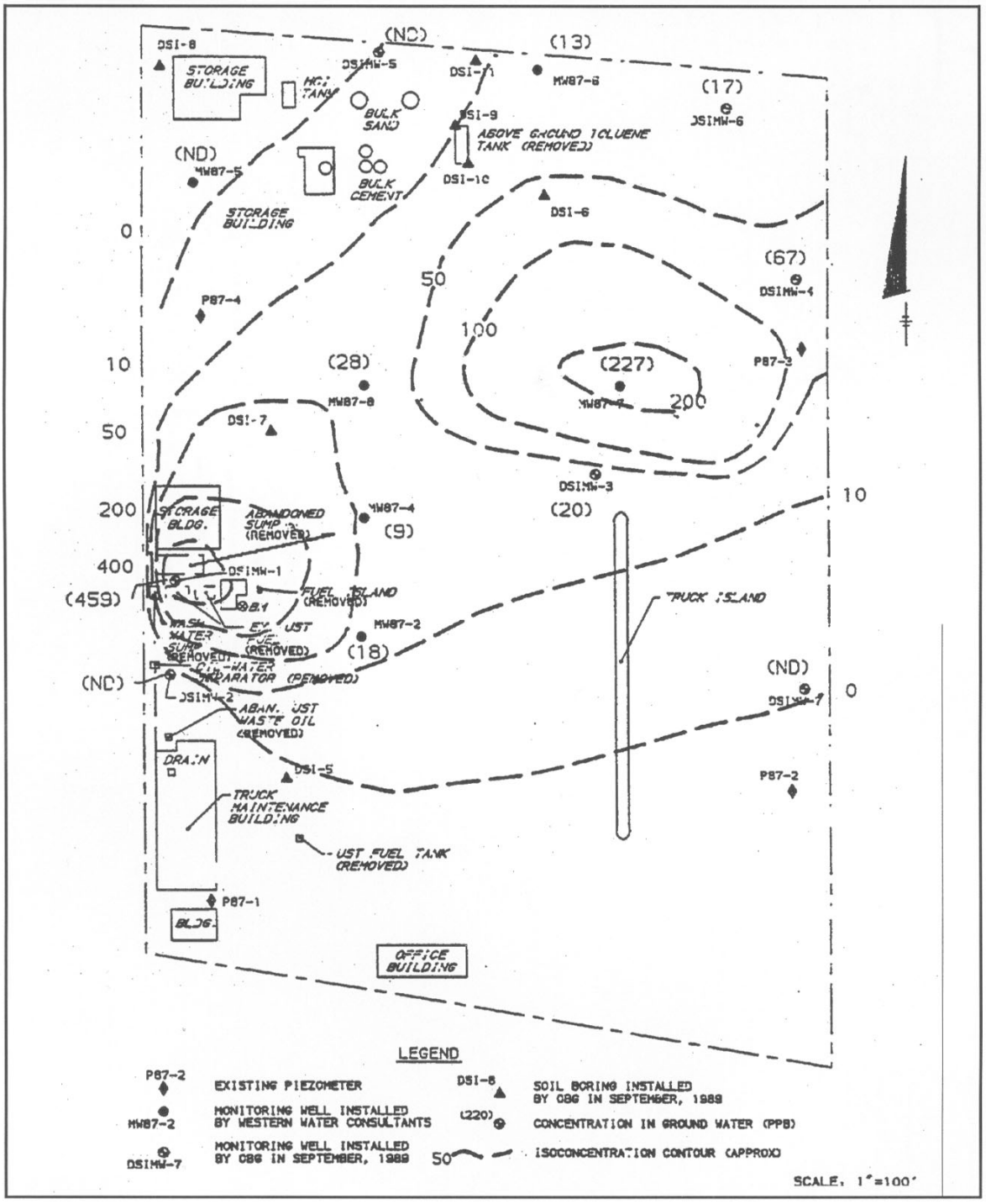


*Figure 1. Concentration Contour Map for Volatile Halogenated Organics (VHO) - Dow/DSI Facility (July 1990)*

## MATRIX DESCRIPTION (CONT.)

**Matrix Characteristics Affecting Treatment Costs or Performance [1] (Cont.)**

*Table 1. Technical Aquifer Information*

| Unit Name | Thickness (ft) | Conductivity (ft/day) | Average Velocity (ft/day) | Flow Direction |
|---|---|---|---|---|
| Alluvial Aquifer | 14.5-81 | 340 | 212 | Northeast |

Source: [1]

## TREATMENT SYSTEM DESCRIPTION

**Primary Treatment Technology**

Pump and treat with air stripping

**Supplemental Treatment Technology**

None

**System Description and Operation**

*Table 2. Extraction Well Data*

| Well Name | Unit Name | Depth (ft) | Yield (gal/min) |
|---|---|---|---|
| XW93-1 | Alluvium | 40 - 45 | 25 |
| XW93-2 | Alluvium | 40 - 45 | 50 |
| XW93-3 | Alluvium | 40 - 45 | 25 |

Source: [2]

**System Description [3,4]**

- The remedial approach at this site was to actively treat the on-site groundwater plume using pump and treat with air stripping, and to allow natural attenuation to reduce contaminant levels in the off-site portion of the plume to levels below MCLs.
- The extraction system consists of three wells placed along the eastern boundary of the Dow/DSI facility. Each well was designed to produce a minimum of 100 gpm. Based on groundwater modeling with Quikflow™, it was determined that a combined pump rate of 100 gpm would be sufficient to maintain hydraulic control over the plume, and not interfere with the pump and treat system at the nearby KN Energy facility. Each well was completed to bedrock and screened over the entire saturated zone.

## TREATMENT SYSTEM DESCRIPTION (CONT.)

**System Description and Operation (Cont.)**

- An infiltration gallery is used to reinject the treated groundwater. A design goal of the infiltration gallery was to minimize mounding at the point of infiltration. A site plan is included as Figure 2. The infiltration trench is 150 feet long, 4 feet wide, and 10 feet deep, for a total of 600 square feet of surface area. The trench has an infiltration capacity of 280 gpm. The bottom 5 feet is filled with washed gravel over a slotted PVC pipe. Another trench was constructed as a backup for when cleaning activities would shut down the primary trench.

- A particle trace test determined that the travel time between the infiltration gallery and the extraction wells was from 70 to 320 days. Based on this information, it was determined that approximately five pore volumes of water should be flushed through the center of the plume each year. Using retardation factors that range from 1.2 to 2.6, the site engineer estimated that TCE would be flushed through the system in a maximum of 0.5 to 1.5 years.

- The air stripper designed for this site has a column diameter of 2.5 feet, a packing height of 30 feet, and a maximum water loading rate of 150 gpm.

- Some design considerations were made based on shared experience with operating a pump and treat system at the KN Energy facility. For instance, the design called for a stripping column that would allow for rapid and easy removal, cleaning, and replacement of the stripping media. It was known, from the KN Energy system, that certain chemical species are likely to precipitate in the tower, fostering biological growth on the stripping media. As a result, the design specified that a chemical treatment system be included to add chelating agent for iron and manganese to inhibit such growth.

- Groundwater contamination and water levels are monitored in a network of 30 wells, placed both on and off site. All 30 wells are sampled quarterly for the seven primary contaminants of concern. Five wells, located off site along the Burlington Northern right-of-way and on a neighboring industrial property are monitored eight times per year for the seven primary contaminants of concern.

**System Operation [5]**

- Remedial construction was completed on June 24, 1994; however, portions of the system were operating on a nearly continuous basis starting from March 28, 1994.

- Quantity of groundwater pumped from aquifer in gallons by year:

| Year | Volume Pumped (gal) |
|---|---|
| 1994 | 36,309,200 (missing data for 11/94) |
| 1995 | 53,808,900 |
| 1996 | 55,472,300 |
| 1997 | 47,167,600 |
| **Total Volume through 1997** | **192,758,000** |

## TREATMENT SYSTEM DESCRIPTION (CONT.)

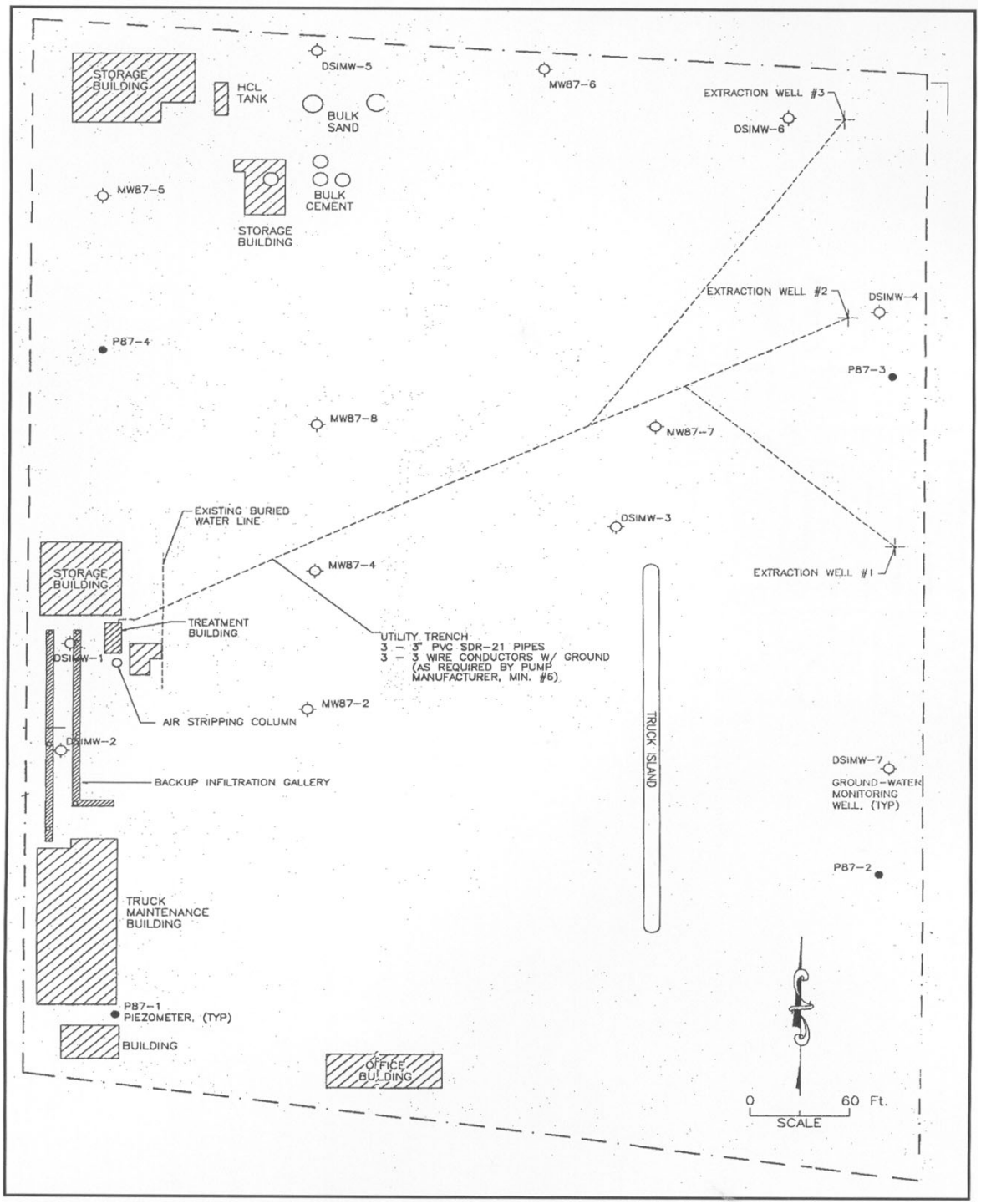


*Figure 2. Site Plan*

## TREATMENT SYSTEM DESCRIPTION (CONT.)

### System Description and Operation (Cont.)

- The system has operated continuously from June 1994 to March 2001. As of May 1998, the most persistent problems were corrosion in the extraction wells and piping. All three extraction pumps were taken out of service and cleaned. The reinjection pump also were taken out of service for repairs. None of these events led to a system shutdown or a loss of hydraulic control on the contaminant plume.

- Air stripping media has never been changed or cleaned. Annual inspections have revealed some build up of iron oxide, but not enough to require media cleaning or replacement.

- It was originally anticipated that cleanup of the site would take approximately six years. At this time, the downgradient portion of the plume appears to be ahead of schedule, i.e., it has achieved or is approaching the performance standards. The upgradient portion of the plume has not achieved the performance standards.

### Operating Parameters Affecting Treatment Cost or Performance

Table 3 presents parameters affecting performance for this technology.

*Table 3. Performance Parameters*

| Parameter | Value |
|---|---|
| Average Pump Rate | 103 gpm |
| Performance Standard (:g/L) | Remedial Goals |
| Remedial Goal<br>TCE<br>PCE<br>trans-DCE<br>cis-DCE<br>1,1-DCE<br>1,1,1-TCA | (:g/L)<br>5<br>5<br>100<br>70<br>7<br>200 |

Source: [4]

### Timeline

Table 4 presents a timeline for this remedial project.

*Table 4. Project Timeline*

| Start Date | End Date | Activity |
|---|---|---|
| 09/90 | --- | Record of Decision for OU1 signed by EPA |
| 3/92 | 6/93 | Remedial design completed |
| 8/93 | 3/94 | Remedial construction begun |
| --- | 6/94 | Remedial construction complete |
| 6/94 | ongoing | Groundwater treatment operational |

Source: [1, 2, 3, 5]

## TREATMENT SYSTEM PERFORMANCE

### Cleanup Goals/Standards [3]

The goal of this remedy is to reduce the level of contaminants in the on-site upgradient portion of the groundwater plume to below MCLs, as shown in Table 3, such that the remainder of the plume off site meets MCLs through natural attenuation within a reasonable time limit.

### Additional Information on Goals

The upgradient portion of the plume was defined as the on-site plume; the downgradient portion of the plume was defined as the off-site plume. Extensive groundwater modeling was used to determine that the cleanup time needed to achieve MCLs in the downgradient portion of the plume would be 6 to 14 years.

### Treatment Performance Goals

The treatment system was designed to reduce contaminant levels in the influent to below MCLs for reinjection of the treated groundwater.

### Performance Data Assessment [5,7,8]

*For this report, total contaminants include TCE, PCE, 1,1,1-TCA, trans-, and cis-1,1-DCE.*

- Contaminant concentrations in all wells have declined significantly, yet remain above MCLs.
- Figure 3 presents the total contaminant concentrations from January 1993 to July 1997 in the wells located closest to the source area. From their initial levels, ranging from 20 : g/L to 70 : g/L, concentrations of all contaminants fell below their respective MCLs in three of four source area wells in the last two sampling events in 1996. In the fourth well, DSIMW-3, total contaminant concentration was 9.4 : g/L. Over time, concentrations of total contaminants have declined in a cyclical pattern, with concentrations spiking periodically, and then falling to levels gradually lower than in previous sampling events.
- Figure 4 presents concentrations of total contaminants detected in wells located near the site boundary, and at the edge of the extraction system capture zone, approximately mid-plume. During the October 1996 sampling event, concentrations of all contaminants were below their respective MCLs in two of four wells and had been at or below their respective MCLs in three of the last four sampling events. In the remaining two wells (DSIMW-4 and MKMW-1), which are both located near the plume centerline, total contaminant concentrations had declined by at least 62 percent from their initial levels, and were measured at 14 : g/L and 9.8 : g/L, respectively.
- Figure 5 shows total contaminant concentrations for the wells located in the downgradient portion of the plume, and which are beyond the hydraulic capture zone of the extraction system. These wells are installed in the downgradient portion of the plume, where, according to the ROD, natural attenuation should be acting to reduce contaminant levels. Total contaminant concentrations have declined in all wells. The sharpest declines were seen in wells EPA1-7 and EPA2-15, located approximately 225 feet downgradient of the site boundary. Total contaminant concentrations declined 72% and 86%, respectively in these two wells over the period from March 1993 to December 1996. Nonetheless, individual contaminants in EPA1-7 remain significantly above their respective MCLs, indicating that contaminants may be migrating past this point. However, concentrations in the wells directly downgradient of EPA1-7 have remained below MCLs since January 1995, suggesting that sufficient natural attenuation is occurring between the two wells.

## TREATMENT SYSTEM PERFORMANCE (CONT.)

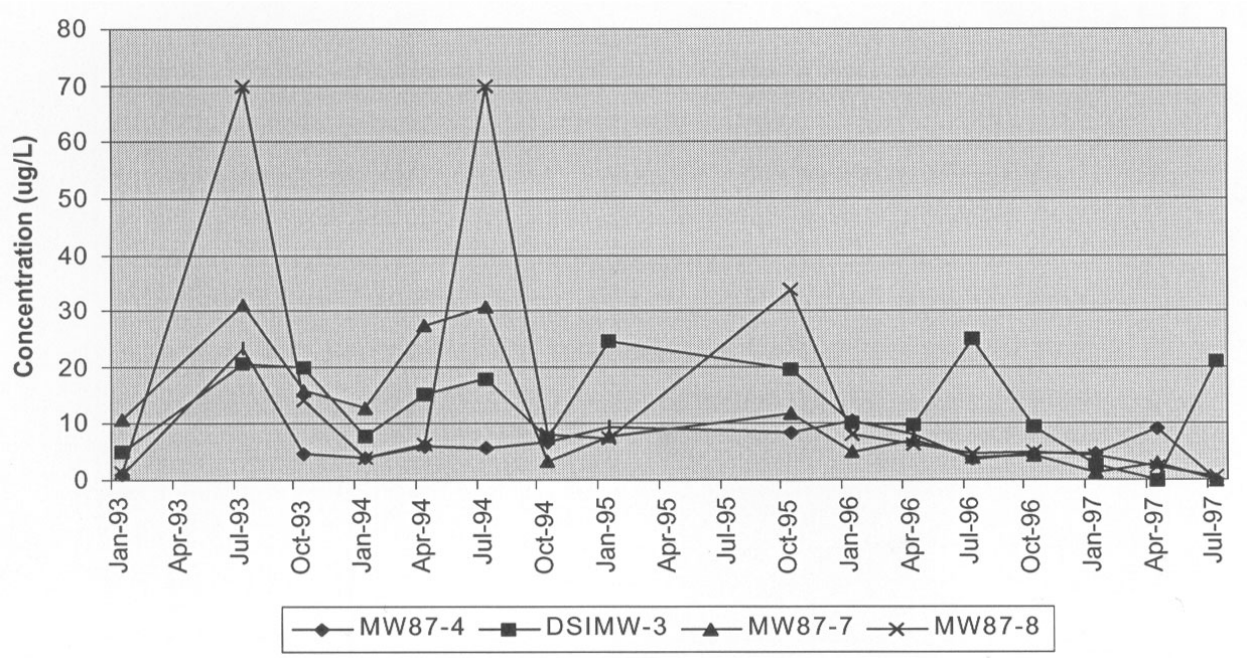


*Figure 3. Total VOC Concentrations in Source Area Wells*

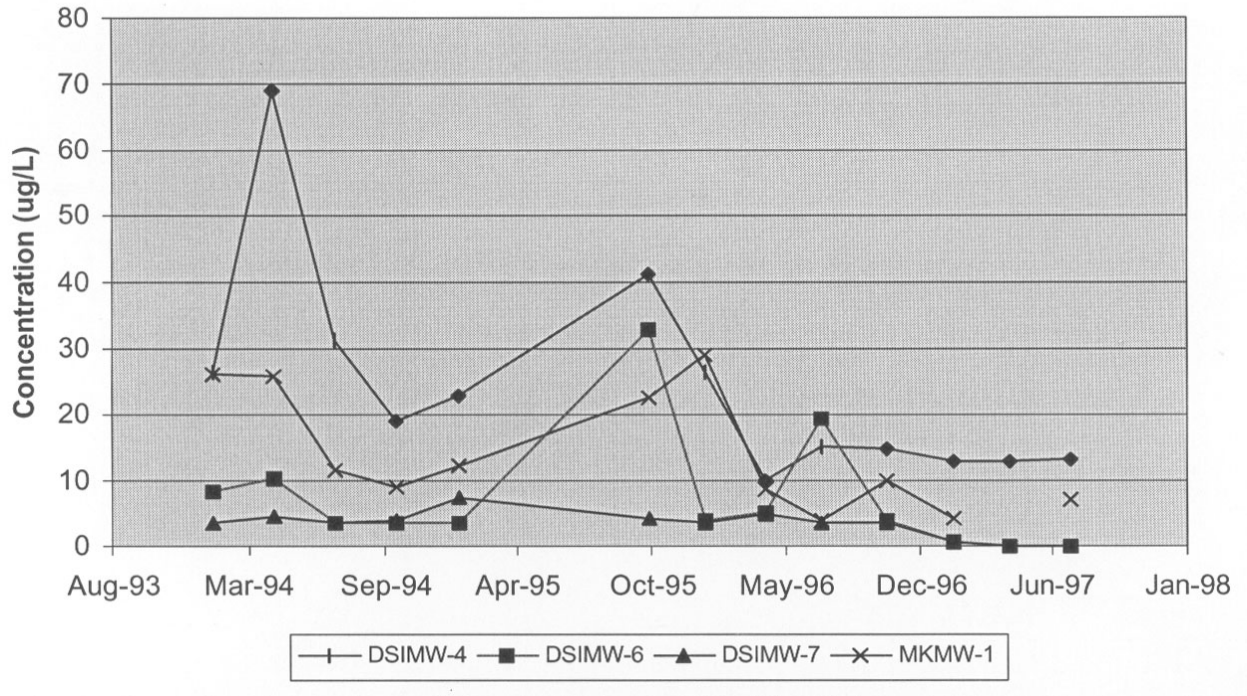


*Figure 4. Total VOC Concentration in Mid-Plume Wells**

* Discontinuous lines indicate that the well was not sampled on that date

## TREATMENT SYSTEM PERFORMANCE (CONT.)

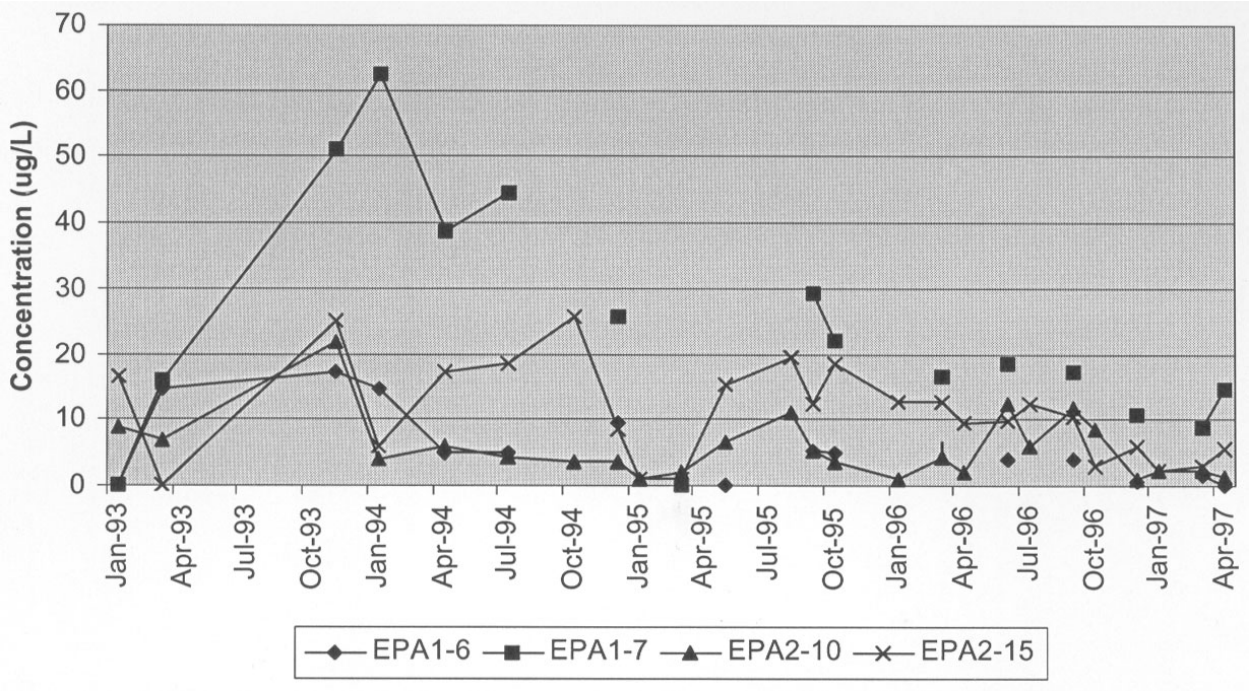


*Figure 5. Total VOC Concentrations in Off-Site Downgradient Wells**

* Discontinuous lines indicate that the well was not sampled on that date

## TREATMENT SYSTEM PERFORMANCE (CONT.)

**Performance Data Assessment [5,7,8] (Cont.)**

- Monthly reports on the treatment system performance indicate that the treatment system has consistently reduced influent concentrations to levels below detection limits.

- Figure 6 reflects on the performance of the treatment system in removing volatile compounds in the influent stream. Figure 5 presents the cumulative mass removed and the mass per day removed in each of the three extraction wells from May 1994 through December 1996. Mass flux through the system, as measured by pounds of contaminant removed per day, has been unusually low for this type of site, and varied from 0.0088E-4 lbs/day to 0.03E-2 lbs/day. Since the beginning of system operations, the efficiency rate has remained close to 0.0073E-3 lbs/day. However, during the final quarter of 1995, this rate increased sharply. This increase follows a sharp increase in contaminant concentrations in many of the monitoring wells during the previous quarter.

- In three years of operation, the treatment system has removed less than 21 pounds of contaminants from the groundwater. Moreover, mass flux rates through the system are very low, reflecting the relatively low concentrations in the influent.

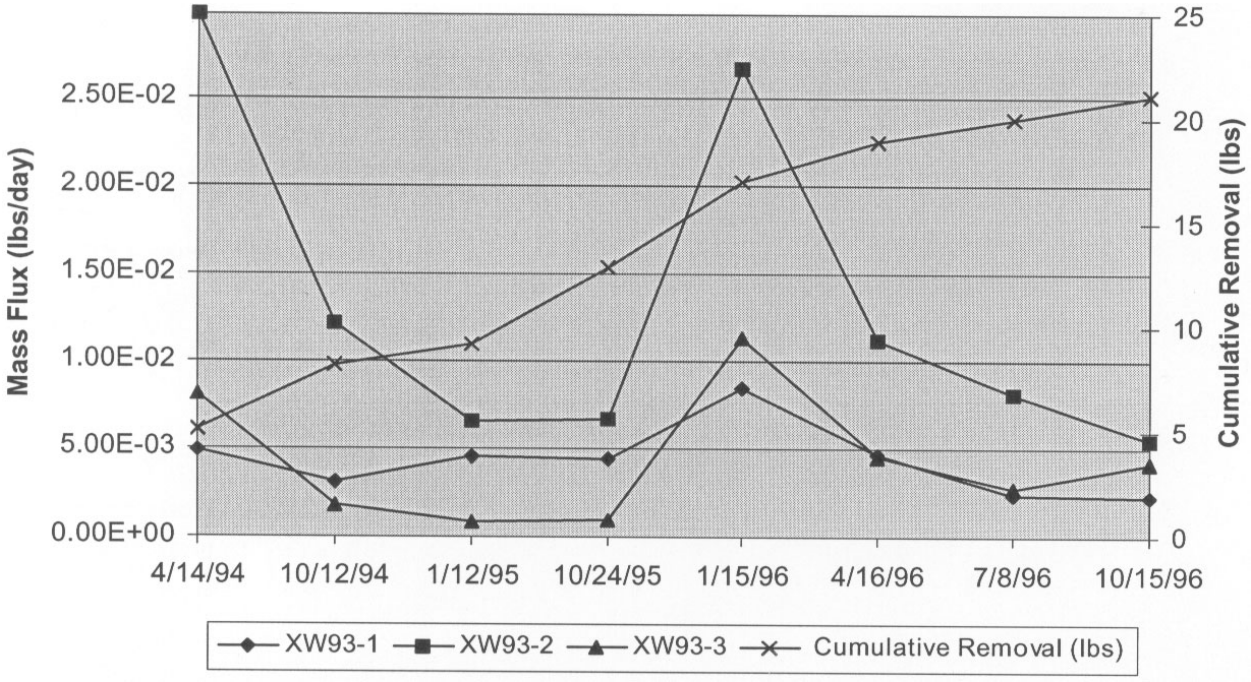


*Figure 6. Mass Flux and Cumulative VOC Removal*

## TREATMENT SYSTEM PERFORMANCE (CONT.)

### Performance Data Completeness

- Quarterly data are available for concentrations of contaminants in the on- site groundwater from 27 monitoring wells and three extraction wells in monthly reports, and in spreadsheets delivered to the EPA RPM between reports. Twice- quarterly data are available for concentrations of contaminants in the off-site groundwater from five monitoring wells.
- Monthly data are available for the volume of groundwater treated by the system (missing November 1994).
- All available data were used in Figures 3 through 6.

### Performance Data Quality [4]

The QA/QC program used throughout the remedial action met the EPA and the State of Wyoming requirements. All monitoring is performed using EPA Method SW 8020, and the vendor did not note any exceptions to the QA/QC protocols.

## TREATMENT SYSTEM COST

### Procurement Process

The PRP, Dow/DSI, contracted with Western Water Consultants, Inc. for engineering, design and oversight services at the facility.

### Cost Analysis

- All costs for investigation, design, construction and operation of the treatment system at the site were borne by Dow/DSI.

### Capital Costs [6]

| | |
|---|---|
| Remedial Construction | $305,352 |

### Operating Costs [6]

| | |
|---|---|
| May 1994 through December 1987 | $612,622 |

### Other Costs [1]

| | |
|---|---|
| Remedial Design | $257,692 |

### Cost Data Quality

Actual costs for this site are available from the PRP.

## OBSERVATIONS AND LESSONS LEARNED [2]

- Concentrations of contaminants in the on-site portion of the plume have been reduced, largely to levels below their respective MCLs. The one exception is well DSIMW-3, where concentration levels remain above MCLs.
- Source removal activities were performed in 1988. With the source areas controlled, initial contaminant groundwater concentrations were relatively low and progress towards remedial goals has been realized by the date of this report.
- The total cost for groundwater remediation at this site through October 1997 was $918,000 ($305,000 in capital costs and $613,000 in operating costs) which corresponds to a unit cost of $5.65 per 1,000 gallons of groundwater treated and $44,000 per pound of contaminant removed.
- Site engineers indicated that it is likely that by the time the RI/FS was performed, further expansion of the plume had ceased. Site engineers reached this conclusion after taking into account the amount of time that the source may have been active and the relatively high mobility of chlorinated solvents in an aquifer of this type. A comparison of the plume geometries over the period 1988 to 1990 showed a slowing rate of growth. Based on this analysis, site engineers concluded that the plume had probably reached an equilibrium between the rate of transport and the rate of degradation by the time that the remedial system was constructed.

## REFERENCES

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2. Obrien & Gere. RI/FS Report: Mystery Bridge Road/Highway 20 Site, Natrona County, Wyoming. June 1990.
3. Western Water Consultants. Design Report for the Dow/DSI Groundwater Remediation System at the Brookhurst/Mystery Bridge Site. February 1993.
4. Western Water Consultants. Operation and Maintenance Plan for the Dow Chemical/Dowell Schlumberger Remedial Design and Remedial Action at the Brookhurst/Mystery Bridge Site. May 21, 1993.
5. Western Water Consultants. Monthly Progress Reports: August 1993 to April 1997. Various dates.
6. Correspondence with Brent Schindler, PRP Counsel, April 13, 1998.
7. Comments on draft report from Tom Jaramillo, Western Water Consultants, May 26, 1998.
8. Comments on draft report from Dennis Mueller, EPA Region VIII May 20, 1998.
9. Correspondence with Rebecca Thomas, EPA RPM, March 16, 2004.

## REFERENCES (CONT.)

**Analysis Preparation**

This case study was prepared for the U.S. Environmental Protection Agency's Office of Solid Waste and Emergency Response, Technology Innovation Office. Assistance was provided by Eastern Research Group, Inc. and Tetra Tech EM Inc. under EPA Contract No. 68-W4-0004.

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